Problem F1 Solution

a) Lift force = \( p_\text{e} A - p_\text{u} A = \Delta p \cdot A \)
where \( A \) = wing area
i.e. net force (lift) is the difference between bottom and top pressure forces.

In level flight, must have lift = weight

\[ \Delta p \cdot A = W \rightarrow \Delta p = \frac{W}{A} = \frac{9 \text{ lb}}{420 \text{ in}^2} = 0.0214 \text{ psi} \]

b) From definition of \( C_p \):
\[ \frac{1}{2} \rho V^2 C_p = \Delta p \rightarrow V = \sqrt{\frac{2 \Delta p}{\rho C_p}} \]

Switch to SI units for convenience: \( \Delta p = 0.0214 \text{ psi} = 147.8 \text{ Pa} \)

At sea level: \( \rho = 1.225 \text{ kg/m}^2 \), so
\[ V = \sqrt{\frac{2 \cdot 147.8 \text{ Pa}}{1.225 \text{ kg/m}^3 \cdot 1}} = 15.53 \text{ m/s} = 34.6 \text{ mph} \]

At 15000 ft: \( \rho = 0.770 \text{ kg/m}^2 \), so
\[ V = \sqrt{\frac{2 \cdot 147.8 \text{ Pa}}{0.770 \text{ kg/m}^3 \cdot 1}} = 19.59 \text{ m/s} = 43.6 \text{ mph} \]

\( \rho \) values obtained from Anderson, App D,